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SOME COMMON DISINFECTANTS

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THE word "infected" means contaminated with or affected by disease germs; "disinfected" means freed of disease germs. A "disinfectant" is a product that destroys disease germs or renders them harmless. An "antiseptic" is a substance that prevents the development and growth of disease germs, but an antiseptic is not a disinfectant unless it is capable of destroying disease germs in addition to preventing their growth.

A disinfectant is not necessarily an "insecticide," for some powerful disinfectants are relatively harmless for insects and the best insecticides may be of little value as disinfectants.

Formaldehyde is one of the most powerful disinfectants known, but it is a very weak insecticide; and, conversely, hydrocyanic acid is deadly for insects and all forms of animal life, while it has little power as a germicide or disinfectant. It is well to remember also that "deodorants" are not necessarily disinfectants—one destroys odors, the other destroys germs.

No single disinfectant is appropriate in all cases. Select the proper substance, apply liberally, allow ample time for the disinfectant to do its work, and remember that success depends in large part upon the care and exactness of the person who prepares and applies the disinfectant.

SOME COMMON DISINFECTANTS.¹

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NEED OF INFORMATION ABOUT DISINFECTANTS.

THERE is much popular misconception regarding the value and limitations of disinfectants. The efficacy of disinfectants is largely dependent upon the mode of application and the kind of material to which they are applied, therefore some knowledge of disinfectants and of their limitations is necessary to obtain the desired results.

In this paper no attempt is made to cover the entire field, but rather to indicate, briefly, the properties and uses of some of the disinfectants that are commonly used about the household and the farm.

FORMALDEHYDE.

Formaldehyde, also called "formic aldehyde," may be obtained on the market in two forms. The one, a sort of condensed formaldehyde, is known as "paraform," and is sold as a white powder or in the form of compressed tablets or pastils. The other is a strong solution of formaldehyde in water and is generally known under the name of "formalin," or solution of formaldehyde. The solution contains from 37 to 40 per cent of formaldehyde.

For practical disinfection the formaldehyde is applied either in the form of gas or vapor or in solution in water. It is most commonly used in gaseous form.

DISINFECTION WITH FORMALDEHYDE GAS.

Gaseous formaldehyde rather than the solution of formaldehyde is commonly employed in cases where the furniture or interior decorations of rooms would be injured or where the value of materials, such as hay and fodder, would be lessened by wetting. In disin-

¹ This is a revision of Farmers' Bulletin 345.

fecting with formaldehyde gas it is essential that a sufficient quantity of gas be liberated and that it be held within the compartment that is to be disinfected for a sufficient length of time to accomplish the destruction of the germs of disease. The gas escapes very readily through any openings or crevices around windows, doors, or elsewhere. Hence it is essential that compartments to be disinfected by formaldehyde gas be tightly closed and that all openings be sealed during the period of disinfection. It is well to remember also that the temperature is an important factor in disinfecting with gaseous formaldehyde, as this disinfectant is much more energetic in a warm atmosphere than in a cold. If the temperature is much below 65° F., disinfection with gaseous formaldehyde can not be relied upon under ordinary circumstances. It is desirable also that the air be moist, and precautions in this respect should be taken in dry weather. In cold weather compartments should be heated.

Various forms of apparatus have been designed for generating formaldehyde gas. Some of these produce the gas from wood alcohol; others are designed to liberate gas by heating solid formaldehyde (paraform), while still others merely volatilize the formaldehyde solution. While these various methods are effective, they require special generating apparatus and are no more effective than simpler means which have now generally replaced the more expensive and complicated processes. The two methods most generally used for applying formaldehyde gas are the spray method and the potassium permanganate method.

SPRAY METHOD.

The spray method is best suited for use in small compartments, such as chests and closets. The commercial 40 per cent solution of formaldehyde is used. This is sprayed directly into small chests and closets, and in the case of small rooms the solution is sprinkled upon a sheet which has been suspended in the room for the purpose. An ordinary sprinkling can, such as is used for watering flowers may be used for spraying the solution of formaldehyde. At least 10 ounces of the solution should be used for each 1,000 cubic feet of space in the room. After spraying the formaldehyde the room or compartment should be quickly closed, keyholes and apertures sealed, and allowed to remain so far at least eight hours.

POTASSIUM PERMANGANATE METHOD.

The potassium permanganate method has now come into quite general use for disinfecting rooms and large compartments. It is carried out by pouring 40 per cent solution of formaldehyde upon crystallized or powdered potassium permanganate. A violent chemical reaction takes place immediately. Heat is generated and

formaldehyde in gaseous form is rapidly liberated. The heat is caused by the reaction between the formaldehyde and the potassium permanganate, and a considerable proportion of the formaldehyde is consumed by this reaction. It has been found that the quantity of gas evolved depends in great measure upon the relative weights of permanganate and of formaldehyde solution that are used. Experiments have shown that the most favorable proportions are 6 parts by weight of 40 per cent formaldehyde solution to 5 parts by weight of chemically pure permanganate of potash. With these proportions approximately 50 per cent of the formaldehyde is liberated in the form of gas.

Allowance must be made for the loss of formaldehyde due to the chemical reaction when arranging for disinfection by this method. As approximately 10 ounces of formaldehyde solution is required for the disinfection of 1,000 cubic feet of space, it is necessary when this method is employed to use twice as much. In practice, therefore, for disinfecting 1,000 cubic feet of space, use 20 ounces of formaldehyde solution by weight to $16\frac{2}{3}$ ounces of potassium permanganate. The needle-shaped crystals of the permanganate should be employed.

To disinfect a room, place the required amount of permanganate in a wide-bottom bucket or basin with flaring sides. An ordinary dish-pan will serve the purpose well. The pan should be raised a short distance from the floor by means of a box or bricks to prevent injury to the floor from the heat, and it is desirable also to protect the floor for some distance around the pan by means of paper or otherwise, as sputtering during the reaction may cause some of the chemicals to splash entirely out of the container. This is less likely to occur if the vessel has good depth.

When everything has been made ready the requisite amount of 40 per cent formaldehyde solution should be poured upon the permanganate, which should have been previously placed in the container, and the room should then be quickly closed and sealed. It should remain closed for at least 8 hours, and a considerably longer period is better in order to assure thorough disinfection. It should be remembered that formaldehyde gas does not penetrate deeply into articles; that it will not quickly enter bureau drawers, closets, and other compartments within the room unless they are opened wide and arranged so that the gas may have free access to them. The same applies to clothing and draperies, which should be hung loose and free in the room. Crevices and cracks around windows, doors, and elsewhere are most conveniently closed by pasting strips of paper over them. All openings into the room should be thus closed except the one through which exit must be had after starting the disinfection. The crevices about the exit can be closed as above indicated after retiring from the room.

DISINFECTION WITH FORMALDEHYDE SOLUTION.

The solution of formaldehyde is a most excellent and reliable disinfectant. For general purposes it is best used by making a 10 per cent solution in water, that is, 10 parts of the 40 per cent solution of formaldehyde made to 100 parts with water. Small objects which will not be injured by wetting may be immersed in the solution. It does not affect metals injuriously except after prolonged action. It is an excellent deodorant as well as a disinfectant and may be usefully employed for disinfecting small areas around the house or stable, for disinfecting discharges from the sick room, and in numerous other ways. It tends to harden skins and render them brittle, and is therefore not suited for the disinfection of furs, but ordinary fabrics are not injured and it usually has little effect upon colors.

ADVANTAGES AND DISADVANTAGES OF FORMALDEHYDE.

The advantages of formaldehyde may be summarized as follows:

1. It is one of the most powerful germicides known.
2. Its action is not hindered greatly by albuminous substances or organic matter.
3. It is not poisonous.
4. It is not injurious to delicate fabrics, to paint, or to metals. (Prolonged contact will affect iron, but not other metals.)
5. It is the only known gaseous disinfectant which can be used effectively and safely in households.

The disadvantages of formaldehyde are as follows:

1. The gas has a strong tendency to condense in cold weather, and it is not reliable as a disinfectant when the temperature of the air is much below 65° F.
2. It has a very penetrating odor, and the gas is irritating to the eyes and nose.
3. To accomplish disinfection by the gas a long period of exposure is necessary and considerable work is required in the proper sealing of rooms which are to be disinfected.

CARBOLIC ACID (PHENOL).

The term "carbolic acid" has been rather loosely employed to designate a variety of substances which, though related chemically, are yet quite different in their disinfecting properties. The true carbolic acid, or phenol, as it is more properly termed, when in a pure state is solid at ordinary temperatures and when freed of water crystallizes in long white needles. Owing to their property of absorbing water from the air the crystals are likely to form a solid cake in bottles and other containers. For this reason carbolic acid is usually dispensed from drug stores in a liquid form prepared by

adding 1 part of water to 9 parts of the crystals. The pure carbolic acid is not well suited for disinfection on a large scale on account of its cost. It is also not so powerful as other disinfectants which may be obtained at a smaller cost.

A 5 per cent solution of pure carbolic acid is a very satisfactory disinfectant for sputum or for discharges from the sick room, and a 2 per cent solution for disinfecting the hands. Fabrics may be disinfected by immersion in a 5 per cent solution for one hour. Carbolic acid does not seem to have the power of killing the germs of certain diseases, such as smallpox and hog cholera, but for most of the ordinary bacteria it is quite effective. Large surfaces are best treated by spraying with a 5 per cent solution. Neither carbolic acid nor other related disinfectants, such as crude carbolic acid, cresol, etc., are suitable for use in refrigerators or compartments where foods are stored nor in barns where dairy cows are kept, for the reason that all food products tend to take up carbolic acid from the air and acquire a disagreeable taste and odor which renders them unfit for food. It should be remembered, likewise, that carbolic acid is one of the most virulent of poisons, and that it is dangerous to leave it around the house in concentrated form.

ADVANTAGES AND DISADVANTAGES OF CARBOLIC ACID (PHENOL).

The advantages of carbolic acid are:

1. It is reasonably effective for destroying most of the common bacteria.
2. Its action is not greatly hindered by organic matter.
3. In a 5 per cent solution it does not materially injure metals or fabrics after contact for one hour or less.
4. It is readily available at all drug stores.

The disadvantages are:

1. It is not effective against all forms of bacteria.
2. It is expensive.
3. It is very poisonous.

CRESOL.

Cresol is found on the market in varying degrees of purity. It is known also under a variety of names, such as tricresol, cresylic acid, liquid carbolic acid, straw-colored carbolic acid, etc. It is a clear, oily liquid and varies in color from light straw to a rather deep reddish brown. It has a strong odor resembling that of pure carbolic acid, and like carbolic acid is quite corrosive when in concentrated form.

The cresol of commerce consists of a mixture of closely related bodies, all of which are superior to pure carbolic acid as disinfectants. It differs from "crude carbolic acid" in being practically free of

coal-tar oils. Commercial grades usually contain from 90 to 98 per cent of cresylic acid or tar acids, and they may be purchased under guaranty of a definite degree of purity. Grades which contain less than 90 per cent of cresylic acid are not so desirable as those of greater purity, for coal-tar oils, generally found in the less pure grades, interfere with the solution of the cresol in water. Under ordinary market conditions cresol is relatively cheap and therefore well suited to the disinfection of cars, barns, and yards. Cresol may be used in the same way as pure carbolic acid, though it is considerably more powerful as a disinfectant and is therefore employed in a weaker solution. Roughly a 2 per cent solution of cresol may be regarded as equivalent to a 5 per cent solution of pure carbolic acid.

In preparing solutions of cresol, allowance should be made for the impurities. Cresol is not readily soluble in water, therefore warm water should be used in making solutions and care should be taken to see that all cresol is dissolved before the disinfectant is used. Cresol is quite poisonous, though less so than pure carbolic acid. While cresol is a more effective disinfectant than carbolic acid, its difficult solubility is a rather serious drawback; therefore, compounds of cresol with soap, which are readily soluble, are better than pure cresol for household and farm use. Many mixtures of cresol with soap are on the market under a variety of names.

COMPOUND SOLUTION OF CRESOL.

The compound solution of cresol is described in the United States Pharmacopœia. Any drug store should be able to prepare it. It is a mixture of cresol with a soap made of linseed oil and potash or soda. This compound solution of cresol is a thick, clear, dark-brown fluid which mixes readily with soft water in all proportions to form a clear, soapy solution. It does not mix well with hard water because the mineral salts in the hard water cause the soap to break up and separate in sticky masses.

A very efficient substitute for the compound solution of cresol may be made from commercial cresol or liquid carbolic acid of known strength by mixing these with ordinary green soap, which is purchasable at all drug stores. Making due allowance for any impurities that exist in the cresol which is used, the green soap is dissolved directly in the cresol, using equal parts of actual cresol and green soap by weight. The cresol is warmed and the soap stirred until it is thoroughly dissolved.

Substitutes for compound solution of cresol are prepared and sold by companies dealing in disinfectants. In many of these soda is used to replace, in whole or in part, the potash, which is much more expensive. The concentrated disinfectant when purchased already prepared should, if of good quality, be entirely homogeneous in com-

position. It should be readily and completely soluble in cold distilled water, and the solution should be practically clear and contain no globules of undissolved oil or cresol.

Compound solution of cresol is used in 2 or 3 per cent solution. The United States Bureau of Animal Industry recommends a solution prepared by dissolving 4 ounces in one gallon of water for disinfecting cars, boats, other vehicles, and premises.

ADVANTAGES AND DISADVANTAGES OF COMPOUND SOLUTION OF CRESOL.

The advantages are:

1. Weight for weight it is much more efficient and is cheaper than pure carbolic acid.
2. It is effective against hog cholera, whereas pure carbolic acid is ineffective.
3. It is very readily soluble.
4. Its soapy character permits good contact with greasy surfaces.

The disadvantages are:

1. It can not be used around compartments where foods are kept because of its odor.
2. It does not mix with hard water.
3. It is poisonous, though much less so than carbolic acid.

CRUDE CARBOLIC ACID.

Crude carbolic acid is a dark, oily fluid that is obtained during the distillation of coal tar, and usually contains little or no true carbolic acid. It has been widely used in this country as a household and farm disinfectant. Essentially, crude carbolic acid is a mixture of oils and "tar acids." The oils are practically devoid of disinfecting power, while the tar acids possess approximately the same disinfecting properties as cresol, to which they are closely related chemically.

Crude carbolic acid of commerce varies greatly with respect to the percentage of tar acid which it contains. Accordingly the disinfecting power will also vary, and crude carbolic acid should be used only when the content of tar acid, or cresylic acid, is known. Even then it must be regarded as of doubtful efficiency if the percentage of oils is relatively large, for the oils will to a great extent prevent solution of the acid in the water when crude carbolic acid is diluted for use as a disinfectant.

The strength of solution required will depend upon the amount of "acid" in the crude carbolic acid. Enough water should be added to produce a 2 per cent solution of tar acid. Thus, crude carbolic acid containing 50 per cent tar acid should be diluted by adding 1 part to 25 parts of water. Thorough stirring is necessary to bring about complete solution of the tar acid. The oils are insoluble and will

float when mixed with water. The disinfecting solution prepared in this way is best applied by means of a spray pump. During the spraying the solution should be agitated so as to effect an even distribution of the oils, which always contain some undissolved tar acids.

There are on the market certain products which are sold under such names as liquid carbolic acid, straw-colored carbolic acid, etc., which should not be confounded with crude carbolic acid. These as a rule contain from 90 to 98 per cent of cresylic acid (tar acid), and are practically free of the oils. These purer products have been referred to in the description of cresol.

There is little to be said in favor of the use of crude carbolic acid as a disinfectant. Its composition is generally uncertain, and it possesses no advantages over other disinfectants, which, considering their power and their ready availability, are to be preferred.

EMULSIFIED COAL-TAR DISINFECTANTS.

The emulsified coal-tar disinfectants are found widely distributed on the market and are sold in cans or bottles of different sizes under a great variety of trade names. They are prepared from coal-tar products and consist of coal-tar oils and tar acids with soap. The product as purchased is a very dark, thick fluid, which should be of uniform consistency throughout. When mixed with water a milky emulsion is formed.

The disinfecting power of the products on the market varies greatly. There is no trustworthy method of determining their relative values by chemical analysis, so a method of comparing them by tests on typhoid-fever germs has been worked out. The power of carbolic acid to kill these germs under certain conditions is worked out in the laboratory, and after tests of the emulsified coal-tar disinfectants have been made under the same conditions their disinfecting power is expressed in the form of a comparison with carbolic acid. This is called the "carbolic-acid coefficient." If the coal-tar disinfectant is five times as effective as carbolic acid it is said to have a carbolic acid coefficient of 5. As a matter of fact, some of these preparations have a coefficient of only 0.5, while others have a coefficient of 20. The user of these products will do well to purchase only those that have a guaranteed carbolic-acid coefficient.

In general these emulsified coal-tar disinfectants have the same uses and properties as carbolic acid and compound solution of cresol, though less poisonous than either. Most of them may be used in a strength of $1\frac{1}{2}$ or 2 per cent.

LIME.

Ordinary quicklime is one of the best and cheapest of disinfectants. It is not commonly applied in the form of quicklime, but in the form of a thick mixture with water known as "milk of lime." The lime

is first slaked by adding 1 pint of water to 2 pounds of quicklime. Considerable heat is generated by this mixture, due to a chemical union of the lime and the water, which forms the hydrate of lime, or water-slaked lime. The development of heat and the crumbling of the hard lumps of quicklime are indications that the lime is of good quality and that it will make a satisfactory milk of lime.

The milk of lime is obtained by adding 4 volumes of water to 1 of the slaked lime and mixing thoroughly. Lime that has been exposed to the air for a long time becomes "air slaked"; that is, it takes up moisture and carbonic acid from the air and is converted into carbonate of lime, which is the same as marble and almost totally worthless as a disinfectant. After quicklime has been slaked with water, the slaked lime and any stock solution of milk of lime that may have been prepared should be kept in tightly closed containers to prevent deterioration, which will result from the action of the air. Whitewash is prepared by adding water to milk of lime until a mixture of suitable density is obtained.

Quicklime may be scattered about yards and lots, and the milk of lime is a good disinfectant for sick-room discharges. It should be added to urine or excreta in liberal quantity and allowed to remain in contact with these discharges for two hours before they are disposed of. Whitewashing of fences, pens, and the interior of out-houses serves to render them more sanitary as well as more attractive in appearance. Lime is well suited for use about dairy barns on account of the lack of any odor. It is preferable to chlorid of lime for that reason.

The advantages of lime as a disinfectant consist in its ready availability and cheapness. It is not, however, a reliable disinfectant against the most resistant forms of germ life such as the spores of the anthrax bacillus.

CHLORID OF LIME.

Chlorid of lime, commonly known as "bleaching powder," but more correctly designated "chlorinated lime," has been in common use for many years. It is a white powder that gives off the disagreeable odor of chlorin. It should be kept in hermetically sealed containers, as exposure to the air causes it to deteriorate rapidly. The efficacy of chlorid of lime is largely dependent upon the amount of available chlorin that it contains. The United States Pharmacopœia requires that at least 35 per cent of chlorin should be present in available form.

While chlorid of lime is a very powerful disinfectant, its potency is immediately and greatly reduced when it is brought into contact with organic matter. This is because the available chlorin combines quickly with the organic matter and is thus diverted from its desired

action upon the germs. In applying chlorid of lime to the disinfection of sick-room discharges, manure, etc., it is important to add it in considerable excess so as to make allowance for the chlorin that will be used up by the organic matter. Besides being a good disinfectant, chlorid of lime is a powerful deodorant.

Chlorid of lime is only partly soluble, therefore in preparing it for use it is well first to rub it up well with a little water so as to break up the lumps, finally diluting to the desired volume. For general household and farm use, 6 ounces of chlorid of lime are mixed with 1 gallon of water.

The uses to which chlorid of lime may be put are restricted because of its corrosive action and its odor. It is a powerful bleaching agent and corrodes metals. Its odor is apt to be absorbed by meat, milk, and other food, and for these reasons its use is not recommended about ice boxes, cellars, or compartments where food is stored or in dairy barns.

BICHLORID OF MERCURY.

Bichlorid of mercury is known also as mercuric chlorid and corrosive sublimate. It is usually sold in the form of tablets in which the bichlorid of mercury is combined with ammonium chlorid which facilitates solution in water. The bichlorid has long been known to be a very powerful disinfectant. However, its power is greatly reduced when it is applied to solutions or substances containing large amounts of organic matter. Bichlorid of mercury is included with other common disinfectants in this bulletin more for the purpose of a warning against its use than for recommending it. It is extremely poisonous and therefore dangerous to have about the house. Many accidents have occurred through its use. It is nothing like so effective or so satisfactory for household use as many of the other disinfectants already described. It tends to attack metals. For these reasons it is not to be recommended as a household disinfectant.

